LIMITED CIRCULATION

This paper is not an official document; it is for information only and must not be quoted in any printed publication without the prior permission of the author.

AGRICULTURAL MEMORANDUM NO. 1052

Allowing for the effect of aspect of sloping ground on published ADAS T-sum figures by C P Roe.

SUMMARY

Although little has been published on the influence of slope aspect on temperatures in the UK, this knowledge could be useful for many purposes of which the application to routine T-sum information to simulate field conditions is just one example.

An experiment was set up to monitor T-sums on moderate slopes of north, south and west-facing aspect from 1 January 1985 on a hilltop 300m asl at Trawsgoed near Aberystwyth. ADAS 40 km grid square T-sums (provided by the Met Office) for square 133 compared favourably with the date of reaching T-200 on the west-facing slope. T-200 occurred nearly two weeks earlier on the south slope than was predicted by the maps while there were 9 days delay before the north slope reached T-200. These differences can be corrected for by reducing the height correction * for south slopes by 100m and increasing it for north slopes by 100m (ie the south slope at 300m is considered to be a level site at 200m etc). By doing this, the ADAS maps predicted T-200 to within 1 day on north and south-facing slopes. With slopes of less than about 10° (1 in 6), the difference is unlikely to advance or retard the date of T-200 by more than a day or two so no correction is necessary.

1. INTRODUCTION

Weekly bulletins of 40 Km grid-square T-sums for the UK have been provided to the farming community by ADAS through Telephone Information Services and the local press. Roe (1984) and Sparks (1983) compared ADAS map estimates with 'on-site' T-sums for selected sites in Wales and the South-West. They concluded that T-sum estimates using the maps were, for most sites, satisfactory. The only exceptions were those sites at high altitude (arbitrarily stated >350m) or those sites on steep north or south-facing slopes. At these difficult sites it was suggested that quality on-site temperature recordings would improve T-sum estimates. The present study shows that even at those sites on steep slopes, a simple height adjustment is all that is necessary to obtain accurate estimates of the date of T-200 from the ADAS figures.

Recipients of T-sum information must bear in mind that T-200 is not at all a critical time for applying first Nitrogen dressing. Soil Scientists have shown that it is far more important to apply N when soil conditions are favourable, than it is to go ahead on the exact date of T-200 (Evans, 1984).

---

* The height correction is given for each grid square and is the amount by which the quoted mean sea level T-sum is reduced per 100m above sea level.

2. THE INFLUENCE OF ASPECT ON TEMPERATURE - A LITERATURE SURVEY

Although there are many references to the influence of topography on temperature lapse rates in hilly terrain (eg Tabony 1983, Roe 1984), it is difficult to quantify the aspect effect because virtually no field work under UK conditions has been reported. In the useful ADAS Reference Book 435 Smith (1984) determined from calculations of radiation inputs that growing season (ie the period during which the 30 cm earth temperature remains above 6°C) on a significant south-facing slope might be increased by 20 days over a level site in the same locality. A significant north-facing slope could expect a 20 days reduction in the length of its growing season. In Wales the decrease of growing season with height is of the order of 20 days per 100m. Thus a south slope is equivalent to a decrease in altitude of 100m for a level site and vice-versa for a north slope.

Whilst Smith's work related to earth temperatures, it is quite feasible to assume that average air temperatures will be similarly effected. This assumption is borne out by the present study.

3. EQUIPMENT AND SITING

The site chosen for the experiment was a small knoll on a hilltop at Trawsgoed near Aberystwyth (NGR of highest point SN 693 735). The proximity of north, south and west-facing slopes within 200m of each other presented an ideal opportunity to study the influence of aspect with the confidence that aspect was the true cause of the difference.

Edale DT85 temperature integrators were set up in 1m square enclosures, fenced off for protection against grazing stock. Roe (1981) found these integrators gave an accurate recording of day °C>0°C; in section 5 the assumption used here that day °C measurements are equivalent to T-sums is discussed. Each integrator was run off a 12V car battery which provided non-stop operation for the duration of the study. The integrator was stored in a plastic food-storage container; silica gell crystals were enclosed in a silver foil dish to prevent the occurrence of high humidities which can cause the integrators to malfunction. The integrator and battery were enclosed in a large plastic bin sack. The grass within each enclosure was cut to simulate grazing by stock. The north and west slopes each had one integrator while the south slope had two to compare T-sums at ground and screen levels. The integrators were read every Monday morning as part of the weekly observing routine of the hill met-site, 100m away to the west.

Thermistor probes were exposed within the grass mat at the soil/air interface. Ideally to measure T-sums, the probes should have been mounted within a Stevenson Screen thereby conforming to Met Office standards. However, this experiment forms part of a longer term study into the affects of aspect on ground temperatures for Agricultural Land Classification input, and a compromise was inevitable. (Further, the hill fort site is classified as one of Special Scientific Interest and digging is discouraged). To determine what effect this might have, one integrator was used with probe mounted in a 'cocoa-tin' at screen height for direct comparison.

4. RESULTS

Figure 1 shows the progression of T-sums from 1 January up to the date of reaching T-200 on each slope. The corresponding map estimate for grid square 133 is indicated by the dotted line. The dates of reaching T-200 are shown in the table below.

TABLE 1

Dates of reaching T-200 in 1985 on slopes of different aspects

Slope	Date of T-200	Difference from map value (days)
South-facing, ground level	10 March	-12
South-facing, screen level	9 March	-13
West-facing	25 March	+ 3
North-facing	31 March	+ 9
ADAS map value (sq. 133)	22 March	-

T-sums on the west-facing slope agreed closest with the ADAS estimate. The south slope reached T-200 nearly two weeks ahead of the map value, irrespective of whether ground level or screen level T-sums are used. On the 10 March the mean sea level T-sum for grid square 133 was 246 day °C, with a height correction of 25 day °C per 100m altitude. Thus on 10 March a level site at 184m asl (ie 246 - 25 x 1.84 = 200) would have reached T-200. A moderate south slope is therefore equal to a drop in altitude in the present study of 300 - 184 = 116m. Corresponding figures for each slope are given in Table 2.

TABLE 2

Equivalent altitudes of level sites to slopes at 300m asl with different aspects at Trawsgoed 1985

Slope	Date of T-200	ADAS sq 133 msl T-sum	Height correction	Equivalent altitude
South-facing, ground level	10 March	246	25	184
West-facing	25 March	301	32	316
North-facing	31 March	348	39	379

Thus a moderate slope with southerly aspect is equivalent to a drop in altitude for a level site of 100m (approx). A northerly slope has an equivalent level site altitude of 100m higher (approx).

A west-facing slope can be considered the same as a level site at the same altitude. These corrections provide a simple way of making the published figures 'site specific'.

5. DISCUSSION

It would have been desirable in this study to record T-sums on each slope with thermistors mounted in a Stevenson Screen. By doing this one could be sure that any measured differences were attributable to the influence of aspect. As it is however, the following problems must be considered:

a. day-degrees were measured and not T-sums;

b. ground level temperatures were measured - of necessity for the Agricultural Land Classification input - and not screen temperatures;

c. degree of slope will directly influence T-sums.

These points will now be considered in turn.

T-sums are identical to day °C>0 so long as temperatures remain above freezing. When the minimum temperature falls below freezing the day °C total will exceed the T-sum. T-sums can never be greater than the accumulated day-degrees so the integrators will have accumulated 200 day °C before T-sum 200 was reached. Observations in the nearby hill met. site suggest that sub-zero temperatures would have given the integrators a 15 day °C advantage over the T-sum by the time T-200 had been reached. During March, the integrators would not have gained more than 1 or 2 days in reaching T-200 and these differences can therefore be ignored.

Figure 1 and Table 1 illustrate that it made little difference to the date of T-200 whether the probe was exposed in a 'cocoa-tin' at screen height or in the grass mat. This is probably because the low radiation inputs at this time of year prevent a build up of large temperature differentials near to the ground. Spackman (1984) compared day °C>0°C at screen height and at 10cm above ground in a 'saucer' screen over a 4 month winter period. He found that the difference was at most ½ day °C per day and for much of the time there was little or no difference at all. One can conclude then that ground level measurements in this instance are a true representation of T-sums in the screen. (This would not be true later in the season, however, where the temperature differential between screen and ground level could be substantial).

The degree of slope can entirely alter its heat budget. In the winter months, when the sun is at low elevation, the temperature differences between slopes will be less than in the summer months. In field studies such as this, one cannot hope to study conditions on a vast range of slopes to see what the effect of gradient is. The solution in the end lies with mathematical models of the thermal regimes of slopes which can cope with slopes of any gradient and aspect. However the role of this study is firstly to provide a first approximation to the aspect problem and secondly to provide data with which to verify the models that will ultimately solve site specific problems.

(An agricultural memorandum will be written in due course explaining more fully the thermal regimes of slopes as measured at Trawsgoed over the January to June period 1985).

6. CONCLUSION

This study shows that a south-facing slope has a considerable advantage over a north-facing slope at similar altitude in terms of the date of reaching T-200. Consciencious farmers using the T-sum system would be well advised to bear this in mind and to try and modify their application of nitrogen dressing according to the lie of the land. However one should not lose sight of the fact that T-200 is only a guide; it is not at all a critical time and it is more important to apply dressing when soil conditions are favourable.

7. ACKNOWLEDGEMENTS

The help and guidance offered by Dr John Starr, Agro-meteorological Officer for Wales, throughout this work is much appreciated.

8. REFERENCES

Evans C (1984) Timing of Nitrogen for Early Grazing. Powys Digest, Divisional Bulletin (February).

Smith L P (1984) The Agricultural Climate of England and Wales, ADAS Reference Book 435, pp 18-19.

Spackman E (1984) A comparison between Accumulated Temperature at Screen height and near Ground level. Agric. Memo. 1017.

Sparks W R (1983) A comparison of on-site observations of T-sums with values interpolated from synoptic maps. Agric. Memo. 993.

Roe C P (1981) Degree-day measurements using an automatic temperature integrator. Agric. Memo. 932.

Roe C P (1984a) A comparison of on-site T-sum observations in Wales with those estimated from Met Office maps. Agric. Memo. 1024.

Roe C P (1984b) Degree-day/T-sum lapse rates in the Welsh hills. Agric. Memo. 1025.

Tabony R C (1983) The variation of surface temperature with altitude. Met 03 Technical Note No 21.

(Copies of Agric. Memos. and Technical Notes are obtainable from the Met Office Library, London Road, Bracknell, Berks).

Any comments or suggestions on this paper should be sent to the author.

KEY WORDS

T-SUMS/ASPECT/SLOPE

Regional Agro-Meteorological Dept
WOAD, Trawsgoed, Aberystwyth,
Dyfed

July 1985

FIGURE 1

T-SUMS ON NORTH, SOUTH AND WEST-FACING SLOPES AT TRAWSGOED 1985 (300m asl)

KEY SS: SOUTH SLOPE SCREEN LEVEL SG: SOUTH SLOPE GROUND LEVEL
A: ADAS GRID SQ. 133 VALUE W: WEST SLOPE N: NORTH SLOPE